The Home Modification of Cow's Milk

"What can equal the glory and joy of the husbandman, as he follows his plough through the furrows of warm rich soil."

Millin's Food Company Boston

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IT is agreed by all authorities that fresh cow's milk must furnish the basis of operations in preparing a substitute for human milk. Cow's milk, however, even when fresh and pure, is, in its undiluted state, of such a nature that the infant cannot digest it, the difficulties arising from the large amount and peculiar properties of the casein. Casein being present in too large a proportion in cow's milk to be digested by the infant's stomach, the proportion of casein must be reduced by dilution with water.

Necessity for Modification.

There is a wide difference, moreover, between the properties of and the results produced by the casein of human milk, on the one hand, and the casein of cow's milk, on the other. The casein of mother's milk, although coagulated with comparative difficulty, forms a soft flocculent clot, readily disintegrated, easily digested. The casein of unmodified cow's milk, on the contrary, is easily coagulated, but is digested with difficulty, and, when coagulated in the infant's stomach, forms tough, coherent curds, which cause constipation and indigestion.

Properties of Casein.

Mother's Milk Alkaline.

Mother's milk when received by the infant is alkaline in reaction. Cow's milk, however, though it may be slightly alkaline when drawn from the udder, soon, from exposure to the air, loses its alkalinity and shows an acid reaction.

Effects of Dilution.

As a result of reducing the amount of casein in cow's milk by dilution with water, the carbohydrates, originally less in amount than in mother's milk, become still further reduced and the deficiency must be made up by the addition of a suitable sugar.

Dilution of cow's milk with water also decreases the proportion of fat, a deficiency which must be overcome by the use of top milk or cream, in amounts to be determined by the needs of individual cases.

These differences suggest the following : —

RULES FOR THE MODIFICATION OF COW'S MILK

1. Reduce the proportion of casein.

2. Modify the casein in order to make it more easily digestible and to correct its tendency to form tough and tenacious curds.

Fundamental Rules for Modification.

3. Make the milk alkaline.

4. Increase the carbohydrates, originally insufficient in amount and made still more so by the necessary dilution.

5 Adapt the quantity of fat to the individual case.

" Smoothly and lightly the golden
Seed by the sower is scattered."

REDUCE THE PROPORTION OF CASEIN

THE dilution of cow's milk with pure water is the best and most practical way to reduce the proportion of casein. Different proportions of milk and water must, however, be used, in order that, as the child grows, the proportion of casein may be increased. The proportion of proteids in mother's milk during the first week or two of lactation is about one per cent. At the sixth month it is about three per cent. In order to bring about similar results in diluting cow's milk with water, varying proportions must be used, according to the age of the child. That there may be about one per cent of proteids in the food of a child two weeks old, about three parts of water to one of milk must be taken, while to have three per cent of proteids for a child six months of age, the proportions are reversed and one part of water to three parts of milk is approximately the correct ratio.

Proportion of Proteids.

" *And the maize field grew and ripened,*
Till it stood in all the splendor
Of its garments green and yellow."

MODIFY THE CASEIN

WHAT is the best way to modify the casein that it may be more digestible, and that its tendency to form tough and tenacious curds may be corrected?

Attenuation of Casein.

In some methods of modifying milk, an attempt is made to attenuate the casein by the addition of milk sugar or starchy products. In combining Mellin's Food with milk the casein is modified and attenuated by the action of the maltose and dextrine in the Mellin's Food.

Casein attenuated by means of *starchy* products is a mechanical mixture only; starch is insoluble and has no action on the casein, and for infants of tender age the introduction of starch into the stomach is not wise and oftentimes absolutely injurious, as young infants do not have the power of digesting starch.

Dextrine a Peptogen.

Milk sugar is incapable of favorably affecting the digestive power of the stomach. Dextrine, present in large quantities in Mellin's Food, being itself a peptogen, facilitates the secretion of pepsin and thereby increases the digestive power.

The addition of Mellin's Food softens the casein and makes it less likely to cause constipation by the formation of hard cheesy masses, but the addition of milk sugar produces no such effect.

Modification of Casein.

The fact that physicians have been unable in many cases to use as high a percentage of proteids in milk modified by milk sugar as they have desired, shows that the *actual* modification of the casein by this means does not take place.

Occlusion.

When milk becomes sour, or when it is acted upon by rennet, it coagulates and the casein separates in clots. Many other substances, if present in the milk at the time this action takes place, are in part occluded and combined with the casein. Professor Leeds gives quantitative results of the amounts of various substances thus carried down. When milk is mixed with a solution of Mellin's Food and the mixture coagulated, a portion of the Mellin's Food is occluded and the result of a quantitative test shows that from twenty-eight to thirty per cent of the weight of the precipitate under such circumstances is Mellin's Food.

Sufficient time for Action.

It has also been found that if the milk and Mellin's Food are mixed and allowed to stand several hours the casein is even more digestible, or, in other words, more casein will be digested in a given time, thus showing that the Mellin's Food *actually modifies the character* of the casein.

Actual Modification.

Repeated experiments made with Mellin's Food and milk on the one hand, and with milk sugar and milk on the other, show that casein occludes more than twice as much Mellin's Food as it does of milk sugar. The occluded Mellin's Food retains, moreover, its character-

istic solubility ; when it is dissolved by the juices of the stomach it leaves the casein soft, flocculent, sponge-like ; easily permeated by the digestive juices and incapable of existing as a tough, tenacious curd.

THE MASON TRIPLETS.

" And now came the reapers, sturdy and strong,
To gather the waving grain."

MAKE THE MILK ALKALINE

IN many methods of modification of cow's milk, the desired alkalinity is obtained by lime water; in others bicarbonate of soda is used. In modification with Mellin's Food we have bicarbonate of potassium.

If we inquire which alkali is the most natural one, i. e., which one is present in greatest quantity in human milk, there can be but one answer — bicarbonate of potassium.

Natural Alkali.

The relative amount of potassium salts is greater in woman's milk than in cow's milk. (Leeds.)

In Harrington's analysis of the ash of human milk, the proportion of total lime salts is 30.24 per cent; of potassium salts, 43.85. The *alkali* present in greatest quantity in the *ash of human milk* is carbonate of *potassium*. Potassium salts predominate largely over the other bases in the mineral constituents or ash of the blood corpuscles and of muscular tissue; potassium phosphate is present in large proportion, while lime salts exist only in small amounts.

Predominance of Potassium.

A solution of lime water freshly made is of definite strength, but if used, a little to-day, a little to-morrow, and more on succeeding days, until half the original amount is gone, the strength of the remaining half is by

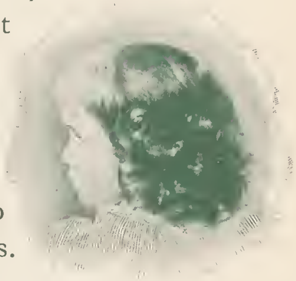
no means equal to that of the original solution. The lime water has been slowly and steadily absorbing from the air carbon dioxide, which has united with the calcium of the lime water. As a result of the union there has been formed and precipitated calcium carbonate, common chalk, a compound absolutely insoluble in water and therefore incapable of being redissolved by the solution. Bicarbonate of potassium, however, whether in solution or in the form of a dry powder, is permanent in composition and invariable in strength.

Unstability of Lime Water.

Combinations of lime with the fatty acids, such as butter fats, are insoluble bodies. When the gastric juice has neutralized the alkalinity of the lime water, the result is chloride of calcium. Combinations of potassium with the fatty acids, however, are bodies soft and readily soluble in water and the result of the neutralizing action of the gastric juice upon bicarbonate of potassium is chloride of potassium, analagous to common salt. If we add to one specimen of milk a weak solution of chloride of calcium and to another, one of chloride of potassium, we find, on adding a solution of rennet, that the potassium salt causes the milk to coagulate in softer and more soluble clots than are those produced by the calcium salt.

Lime Salts Insoluble.

Softer Curds with Potassium.



Potassium salts are less liable to cause constipation than lime salts. (Cheadle.)

Potassium salts are more effective in preventing the discharge of hard curds than lime salts. (Roberts.) *Prevention of Constipation.*

From the foregoing we summarize these facts: —

1. In the ash of human milk the alkalinity depends upon the presence of potassium salts and *not* of lime salts.

2. Potassium bicarbonate is permanent in composition, while lime water is often of deficient alkalinity and always variable.

3. Potassium salts of the fatty acids are soft and soluble. *Lime salts* are *insoluble.*

4. Potassium chloride causes a slower coagulation and less tough curds than do lime salts. *Slow Coagulation.*

5. Potassium salts are less likely to cause constipation than are lime salts.

" Turn, turn, O mill! Turn round and round,
Without a pause, without a sound."

INCREASE THE CARBOHYDRATES

Deficiency of Carbohydrates.

BY the dilution of cow's milk with water, in order to lessen the proportion of casein, the small percentage of carbohydrates becomes still less. This deficiency must be made up. In many attempts at modification of cow's milk the deficiency of carbohydrates is overcome by the addition of milk sugar. In the modification by Mellin's Food the needed carbohydrates are supplied by the maltose and dextrine in the Mellin's Food.

Composition of Carbohydrates.

The carbohydrates by their oxidation keep up the supply of heat in the system, — not that this is their sole office, but it is probably their principal function.

Which of the sugars, milk sugar or maltose, is capable of supplying the greatest heat? The chemical formulas are identical.

Milk sugar — $C_{12}\,H_{22}\,O_{11}+H_2\,O$
Maltose — $C_{12}\,H_{22}\,O_{11}+H_2\,O$

(Roscoe).

Amount of Heat Units.

There are the same number of units of Carbon and Hydrogen in each sugar, and by oxidation they necessarily yield the same amounts of carbonic acid and

water and consequently produce the same amount of energy. There can be no difference in their action in *this* respect.

Milk Sugar.

Is it true that human milk contains commercial milk sugar? Is it true that when commercial milk sugar is added to an infant food the sugar is in precisely the same condition as it exists in natural milk? Do we *know* that the sugar obtained from cow's milk is physiologically identical with the sugar existing in human milk? The caseins are different; the mineral salts are different; why then should it be taken for granted that the sugars are identical? A freshly made solution of milk sugar is different in some of its properties from a solution which has been allowed to stand for several hours. Tested by the polariscope the rotating power of a fresh solution of milk sugar is nearly double that of the *same* solution after standing. The solubility of different brands of commercial milk sugar varies. Pavy has shown that milk sugar obtained by treating the milk with rennet gives different reactions from those which occur in milk sugar obtained by the use of acetic acid. Commercial milk sugar is a chemical product; it is a waste product obtained from the whey which comes from cheese factories. The whey when sour is neutralized with lime or magnesia and hence lactates of these bases are often found in the ash of the milk sugar.

Peculiarities of Milk Sugar.

Professor Leeds states that in all his examinations of

milk sugar obtained from drug stores, an abundant crop of bacteria developed when samples were submitted to the ordinary gelatin-peptone culture.

Bacteria in Milk Sugar.

Dr. E. F. Brush says:—

"Sugar of milk in *human* milk is all assimilated, while the milk sugar of commerce, when added to baby's food, is eliminated both by the kidneys and bowels. This I have demonstrated by numerous experiments."

Milk Sugar Eliminated.

Maltose is assimilated without further change in the intestinal tract.

Maltose does not readily undergo acetous fermentation. (Fothergill.)

It (Maltose) will *not* give rise to acidity and dyspepsia. (Dr. Mitchell Bruce.)

There is, therefore, not the slightest reason for thinking that milk sugar, for any reason, either theoretical or practical, is as desirable as maltose as a means of increasing the carbohydrates in milk.

Maltose Preferable.

"Ora et Labora."

ADAPT THE AMOUNT OF FAT

WHILE, on the one hand, the cow's milk must be so modified that the casein shall be reduced, the relative proportions of casein and albumen adjusted, the casein rendered soluble and digestible, the milk made alkaline and the deficiency of the carbohydrates overcome, the adaptation of the amount of fat, on the other hand, gives opportunity for greater consideration and can be determined only by the requirements, conditions and idiosyncrasies of the individual. When milk is modified by Mellin's Food all the fat must needs be supplied by the milk, since the Mellin's Food itself contains only an inconsiderable amount of fat derived from the grains used in its manufacture. An additional amount of fat, if required, may be obtained by the use of top milk or cream.

Fat to Suit Condition.

" He has carried every point who has
mingled the useful with the agreeable."

MELLIN'S FOOD FROM AN ETHICAL STANDPOINT

Mellin's Food is the only true Liebig's Food.

Mellin's Food is not patented nor is its formula secret.

Its formula was freely given to the world by the chemist, Baron Justus von Liebig, who first used it in his own family.

It was first made in liquid form, being a true modified milk.

G. Mellin of London, after many trials, succeeded in making a dry extract, which, when added to fresh, raw milk reproduced Liebig's original preparation.

Mellin's Food is not affected by either time or climate.

Liebig gave a new principle of infant feeding. Mellin has made Liebig's Food possible in every home.

What Mellin's Food was, when first made, it is to-day.

FORMULAS AND ANALYSES

AS an illustration of the wide range possible in the modification of cow's milk with Mellin's Food, we give a series of formulas which have been arranged with due regard to the limitations of the home. If the percentage of proteids in these seems greater than the proportion of proteids known to exist in cow's milk, when diluted with the given amount of water, it must be remembered that the proteids come not only from the casein of the cow's milk but also from the *soluble* and *digestible* albumen of the Mellin's Food.

Soluble Proteids of Mellin's Food.

Realizing that it is not the child's age alone which determines the needed amounts of proteids, carbohydrates, salts or fat, but that other factors — strength, weight, vigor, etc. — exert their influences, we must not regard these formulas as cast-iron rules to be followed in modifying milk for children of different ages, but we must look upon them as guides in selecting the proper proportions. To the practitioner they will suggest other formulas, and will show that, when necessary, any desired proportion of constituents may be obtained by varying the proportions of the Mellin's Food, milk, cream and water.

Any Proportion Obtainable.

For Infants about Two Weeks Old.

Mellin's Food, 4 teaspoonfuls; Milk, 4¼ fluid ounces; Water, 11¾ fluid ounces.	Gives this Composition	Fat	1.01
		Proteids	1.12
		Carbohydrates (no starch)	2.01
		Salts	.23
		Water	95.63
			100.00

For Infants about One Month Old.

Mellin's Food, 5 teaspoonfuls (level); Milk, 5 fluid ounces; Water, 11 fluid ounces.	Gives this Composition	Fat	1.18
		Proteids	1.32
		Carbohydrates (no starch)	2.42
		Salts	.28
		Water	94.80
			100.00

For Infants about Six Weeks Old.

Mellin's Food, 5 teaspoonfuls (level); Milk, 6 fluid ounces; Water, 10 fluid ounces.	Gives this Composition	Fat	1.41
		Proteids	1.56
		Carbohydrates (no starch)	2.69
		Salts	.32
		Water	94.02
			100.00

For Infants about Two Months Old.

Mellin's Food, 6 teaspoonfuls (level); Milk, 6½ fluid ounces; Water, 9½ fluid ounces.	Gives this Composition	Fat	1.53
		Proteids	1.69
		Carbohydrates (no starch)	3.03
		Salts	.35
		Water	93.40
			100.00

For Infants about Three Months Old.

Mellin's Food, 1 tablespoonful (heaping); Milk, 8 fluid ounces; Water, 8 fluid ounces.	Gives this Composition	Fat	1.86
		Proteids	2.08
		Carbohydrates (no starch)	3.82
		Salts	.44
		Water	91.80
			100.00

For Infants about Three Months Old. (Rich milk.)

Mellin's Food, 1 tablespoonful (heaping); Rich Milk, 8 fluid ounces; Water, 8 fluid ounces.	Gives this Composition	Fat	2.13
		Proteids	1.99
		Carbohydrates (no starch)	4.19
		Salts	.51
		Water	91.18
			100.00

For Infants about Four Months Old.

Mellin's Food, 10 teaspoonfuls (level); Milk, 9½ fluid ounces; Water, 6½ fluid ounces.	Gives this Composition	Fat	2.19
		Proteids	2.47
		Carbohydrates (no starch)	4.60
		Salts	.52
		Water	90.22
			100.00

For Infants about Five Months Old.

Mellin's Food, 13 teaspoonfuls (level); Milk, 10½ fluid ounces; Water, 5½ fluid ounces.	Gives this Composition	Fat	2.40
		Proteids	2.75
		Carbohydrates (no starch)	5.42
		Salts	.59
		Water	88.84
			100.00

For Infants about Six Months Old.

	Gives this Composition	
Mellin's Food, 2 tablespoonfuls (heaping);	Fat	2.72
Milk, 12 fluid ounces;	Proteids	3.14
Water, 4 fluid ounces.	Carbohydrates (no starch)	6.35
	Salts	.68
	Water	87.11
		100.00

For Infants about Six Months Old. (Rich milk.)

	Gives this Composition	
Mellin's Food, 2 tablespoonfuls (heaping);	Fat	3.10
Rich Milk, 12 fluid ounces;	Proteids	3.00
Water, 4 fluid ounces.	Carbohydrates (no starch)	6.90
	Salts	.79
	Water	86.21
		100.00

For Infants about Six Months Old. (Top milk.)

	Gives this Composition	
Mellin's Food, 2 tablespoonfuls (heaping);	Fat	4.04
Top Milk, (upper half of milk after standing 4 hours) 12 fluid ounces;	Proteids	3.04
Water, 4 fluid ounces.	Carbohydrates (no starch)	6.73
	Salts	.77
	Water	85.42
		100.00

Low Proteids.

	Gives this Composition	
Mellin's Food, 2 tablespoonfuls (heaping);	Fat	2.50
Milk, 4 fluid ounces;	Proteids	1.45
Cream, 1½ tablespoonfuls;	Carbohydrates (no starch)	4.18
Water, 12 fluid ounces.	Salts	.37
	Water	91.50
		100.00

Low Proteids and Low Carbohydrates.

Mellin's Food, 11 teaspoonfuls (level); Tòp Milk, (upper half of milk after standing 4 hours) 6 fluid ounces; Water, 10 fluid ounces.	Gives this Composition	Fat	2.25
		Proteids	1.58
		Carbohydrates (no starch)	4.07
		Salts	.42
		Water	91.68
			100.00

High Fat and Low Proteids.

Mellin's Food, 3 tablespoonfuls (heaping); Milk, 4 fluid ounces; Cream, 2 tablespoonfuls; Water, 12 fluid ounces.	Gives this Composition	Fat	3.00
		Proteids	1.65
		Carbohydrates (no starch)	5.54
		Salts	.45
		Water	89.36
			100.00